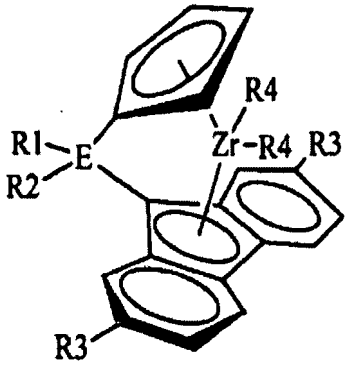
AMMENDMENTS TO THE CLAIMS

The following listing of the claims is provided in accordance with 37 C.F.R. §1.121.

1-22. (canceled)

23. (currently amended) A catalyst composition consisting essentially of the contact product of at least one metallocene compound and at least one chemically-treated solid oxide, wherein:

a) the at least one metallocene compound is selected from a compound of the formula:



;

wherein E is selected from C, Si, Ge, or Sn; R1 is selected from H or a hydrocarbyl group having from 1 to about 20 carbon atoms; R2 is selected from an alkenyl group having from about 3 to about 12 carbon atoms; and R3 is selected from H or a hydrocarbyl group having from 1 to about 12 carbon atoms; and R4 is selected from H or a hydrocarbyl group having from 1 to about 20 carbon atoms ~~has the following formula:~~

~~$(X^1)(X^2)(X^3)(X^4)M^1$;~~

~~wherein M^1 is selected from titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, or tungsten;~~

~~(X^1) is selected from a Group-I ligand,~~

~~wherein the Group-I ligand is selected from a cyclopentadienyl, an indenyl, a fluorenyl, a substituted cyclopentadienyl, a substituted indenyl, or a substituted fluorenyl;~~

~~wherein each substituent on the substituted cyclopentadienyl, substituted indenyl, or substituted fluorenyl (X^1) is independently selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen;~~

~~(X^3) is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, or a substituted derivative thereof, having from 1 to about 20 carbon atoms;~~

~~(X^4) is independently selected from a Group-II ligand,~~

~~wherein the Group-II ligand is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a~~

~~silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide;~~

~~(X^2) is independently selected from a Group I or a Group II ligand;~~

~~wherein (X^1) and (X^2) are optionally connected by a bridging group, wherein the length of the bridging group between (X^1) and (X^2) is one, two, or three atoms; the one, two, or one, two, or three atoms of the bridging group are independently selected from C, Si, Ge, or Sn; the bridging group is saturated or unsaturated; and the bridging group is substituted or unsubstituted; and~~

~~wherein any substituent on the bridging group is independently selected from an alkenyl group, an alkynyl group, an alkadienyl group, an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen~~; and

b) the at least one chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

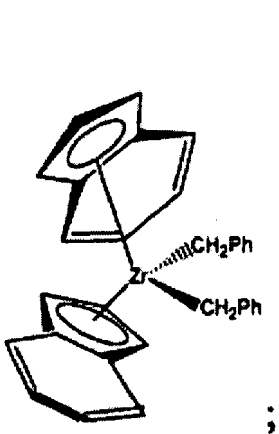
wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof.

24. (canceled)

25. (currently amended) ~~The catalyst composition of Claim 23, wherein~~ A catalyst composition consisting essentially of the contact product of at least one metallocene compound and at least one chemically-treated solid oxide, wherein:

a) the at least one metallocene compound is selected from:



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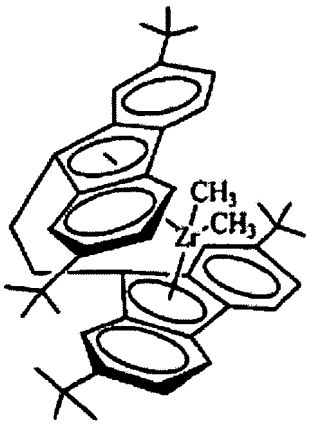

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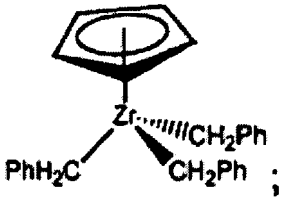

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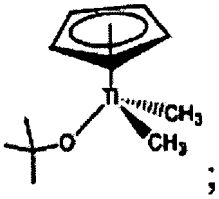

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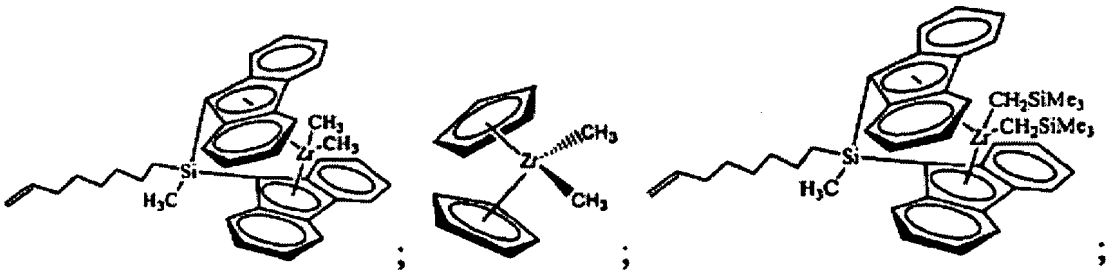

or any combination thereof[[.]]; and

b) the at least one chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof.

26. (currently amended) ~~The catalyst composition of Claim 23, wherein~~ A catalyst composition consisting essentially of the contact product of at least one metallocene compound and at least one chemically-treated solid oxide, wherein:

a) the at least one metallocene compound is selected from:

bis(cyclopentadienyl)hafnium dimethyl;

bis(cyclopentadienyl)zirconium dibenzyl;

1,2-ethanediylbis(η^5-1-indenyl) dimethylhafnium;

1,2-ethanediylbis(η^5-1-indenyl)dimethylzirconium;

3,3-pentanediylbis(η^5-4,5,6,7-tetrahydro-1-indenyl)hafnium dimethyl;

methylphenylsilylbis(η^5-4,5,6,7-tetrahydro-1-indenyl)zirconium dimethyl;

bis(1-*n*-butyl-3-methyl-cyclopentadienyl) zirconium dimethyl;

bis(*n*-butylcyclopentadienyl)zirconium dimethyl;

dimethylsilylbis(1-indenyl)zirconium bis(trimethylsilylmethyl);

octyl(phenyl)silylbis(1-indenyl)hafnium dimethyl;

dimethylsilylbis(η^5-4,5,6,7-tetrahydro-1-indenyl)zirconium dimethyl;

dimethylsilylbis(2-methyl-1-indenyl)zirconium dibenzyl;

1,2-ethanediylbis(9-fluorenyl)zirconium dimethyl;

(indenyl)trisbenzyl titanium(IV);

(isopropylamidodimethylsilyl)cyclopentadienyltitanium dibenzyl;

bis(pentamethylcyclopentadienyl)zirconium dimethyl;

bis(indenyl) zirconium dimethyl;

methyl(octyl)silylbis(9-fluorenyl)zirconium dimethyl;

bis(2,7-di-*tert*-butylfluorenyl)-ethan-1,2-diyl)zirconium(IV) dimethyl;

or any combination thereof[[.]]; and

b) the at least one chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide,

phosphate, triflate, bisulfate, sulfate, or any combination thereof.

27. (currently amended) A catalyst composition consisting essentially of the contact product of a metallocene compound and a chemically-treated solid oxide, wherein:

a) the metallocene compound has the following formula:

$$(X^1)\ (X^2)(X^3)(X^4)\ M^1;$$

wherein M^1 is selected from titanium, zirconium, hafnium, or vanadium;

(X^1) is selected from a cyclopentadienyl, an indenyl, a fluorenyl, a substituted cyclopentadienyl, a substituted indenyl, or a substituted fluorenyl;

wherein each substituent on the substituted cyclopentadienyl, substituted indenyl, or substituted fluorenyl (X^1) is independently selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen; and

(X^2),(X^3), and (X^4) are independently ~~seleced~~ selected from a hydrocarbyl group or a substituted hydrocarbyl group, having from 1 to about 20 carbon atoms; and

b) the chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof.

28. (previously presented) A catalyst composition consisting essentially of the contact product of a metallocene compound and a chemically-treated solid oxide, wherein:

a) the metallocene compound has the following formula:

$$(\eta^5\text{-cycloalkadienyl})M^2R^2_nX_{3-n};$$

wherein cycloalkadienyl is selected from cyclopentadienyl, indenyl, fluorenyl, or substituted analogs thereof;

M^2 is selected from Ti, Zr, or Hf;

R^2 is independently selected from substituted or non-substituted alkyl, cycloalkyl, aryl, aralkyl, having from 1 to about 20 carbon atoms;

X is independently selected from F; Cl; Br; I; or substituted or non-substituted alkyl, cycloalkyl, aryl, aralkyl, alkoxide, or aryloxide having from 1 to about 20 carbon atoms; and

n is an integer from 1 to 3 inclusive; and

b) the chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof.

29. (canceled)

30. (previously presented) A process to produce a catalyst composition comprising contacting a metallocene compound and a chemically-treated solid oxide, wherein:

a) the metallocene compound has the following formula:

$$(X^1)\ (X^2)(X^3)(X^4)\ M^1;$$

wherein M^1 is selected from titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, or tungsten;

(X^1) is selected from a Group-I ligand,

wherein the Group-I ligand is selected from a cyclopentadienyl, an indenyl, a fluorenyl, a substituted cyclopentadienyl, a substituted indenyl, or a substituted fluorenyl;

wherein each substituent on the substituted cyclopentadienyl, substituted indenyl, or substituted fluorenyl (X^1) is independently selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an

aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, -SX, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen;

(X^3) is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, or a substituted derivative thereof, having from 1 to about 20 carbon atoms;

(X^4) is independently selected from a Group-II ligand,

wherein the Group-II ligand is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, -SX, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide;

(X^2) is independently selected from a Group-I or a Group-II ligand;

wherein (X^1) and (X^2) are optionally connected by a bridging group, wherein the length of the bridging group between (X^1) and (X^2) is one, two, or three atoms; the one, two, or one, two, or three atoms of the bridging group are independently selected from C, Si, Ge, or Sn; the bridging group is saturated or unsaturated; and the bridging group is substituted or unsubstituted; and

wherein any substituent on the bridging group is independently selected from an alkenyl group, an alkynyl group, an alkadienyl group, an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, -SX, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen; and

b) the chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof;

wherein the catalyst composition is substantially free of an organoaluminum compound having the formula:

$$Al(X^5)_n(X^6)_{3-n}$$

wherein (X^5) is a hydrocarbyl having from 1 to about 20 carbon atoms;

wherein (X^6) is a halide, hydride, or alkoxide; and

wherein n is a number from 1 to 3 inclusive; and

wherein the catalyst composition will produce a polyolefin when added to an olefin.

31. (previously presented) A process for polymerizing olefins in the presence of a catalyst composition, comprising contacting the catalyst composition with at least one type of olefin monomer, wherein the catalyst composition consists essentially of the contact product of:

a) a metallocene compound having the following formula:

$$(X^1)\ (X^2)(X^3)(X^4)\ M^1;$$

wherein M^1 is selected from titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, or tungsten;

(X^1) is selected from a Group-I ligand,

wherein the Group-I ligand is selected from a cyclopentadienyl, an indenyl, a fluorenyl, a substituted cyclopentadienyl, a substituted indenyl, or a substituted fluorenyl;

wherein each substituent on the substituted cyclopentadienyl, substituted indenyl, or substituted fluorenyl (X^1) is independently selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is

a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen;

(X^3) is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, or a substituted derivative thereof, having from 1 to about 20 carbon atoms;

(X^4) is independently selected from a Group-II ligand,

wherein the Group-II ligand is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide;

(X^2) is independently selected from a Group-I or a Group-II ligand;

wherein (X^1) and (X^2) are optionally connected by a bridging group, wherein the length of the bridging group between (X^1) and (X^2) is one, two, or three atoms; the one, two, or one, two, or three atoms of the bridging group are independently selected from C, Si, Ge, or Sn; the bridging group is saturated or unsaturated; and the bridging group is substituted or unsubstituted; and

wherein any substituent on the bridging group is independently selected from an

alkenyl group, an alkynyl group, an alkadienyl group, an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen;

b) the chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof; and

wherein the catalyst composition will produce a polyolefin when added to an olefin.

32. (previously presented) A catalyst composition comprising the contact product of at least one metallocene compound, a cocatalyst, and at least one chemically-treated solid oxide, wherein:

a) the at least one metallocene compound having the following formula:

(X^1) $(X^2)(X^3)(X^4)$ M^1;

wherein M^1 is selected from titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, or tungsten;

(X^1) is selected from a Group-I ligand,

wherein the Group-I ligand is selected from a cyclopentadienyl, an indenyl, a fluorenyl, a substituted cyclopentadienyl, a substituted indenyl, or a substituted fluorenyl;

wherein each substituent on the substituted cyclopentadienyl, substituted indenyl, or substituted fluorenyl (X^1) is independently selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, $-SX$, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen;

(X^3) is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, or a substituted derivative thereof, having from 1 to about 20 carbon atoms;

(X^4) is independently selected from a Group-II ligand,

wherein the Group-II ligand is selected from an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a

silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, -SX, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide;

(X^2) is independently selected from a Group-I or a Group-II ligand;

wherein (X^1) and (X^2) are optionally connected by a bridging group, wherein the length of the bridging group between (X^1) and (X^2) is one, two, or three atoms; the one, two, or one, two, or three atoms of the bridging group are independently selected from C, Si, Ge, or Sn; the bridging group is saturated or unsaturated; and the bridging group is substituted or unsubstituted; and

wherein any substituent on the bridging group is independently selected from an alkenyl group, an alkynyl group, an alkadienyl group, an aliphatic group, an aromatic group, a cyclic group, a combination of aliphatic and cyclic groups, an oxygen group, a sulfur group, a nitrogen group, a phosphorus group, an arsenic group, a carbon group, a silicon group, a germanium group, a tin group, a lead group, a boron group, an aluminum group, $-SO_2X$, $-OAlX_2$, $-OSiX_3$, $-OPX_2$, -SX, $-OSO_2X$, $-AsX_2$, $-As(O)X_2$, or $-PX_2$, wherein X is selected independently from halide, H, NH_2, OR, or SR, wherein R is a hydrocarbyl, or a substituted derivative thereof, having from 1 to about 20 carbon atoms; a halide; or hydrogen;

b) the cocatalyst is selected from an aluminoxane, an organozinc compound, an organoboron compound, an ionizing ionic compound, a clay material, or any combination

thereof; and

c) the at least one chemically-treated solid oxide comprises a solid oxide treated with an electron-withdrawing anion;

wherein the solid oxide is selected from silica, alumina, silica-alumina, silica-zirconia, alumina-zirconia, aluminum phosphate, heteropolytungstates, titania, magnesia, boria, zinc oxide, mixed oxides thereof, or mixtures thereof; and

the electron-withdrawing anion is selected from fluoride, chloride, bromide, phosphate, triflate, bisulfate, sulfate, or any combination thereof.